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ARTICLE

# Variation of Linear and Nonlinear Parameters in the Swim Strokes According to the Level of Expertise

**Tiago M. Barbosa and Wan Xiu Goh**
Nanyang Technological University

**Jorge E. Morais**
Polytechnic Institute of Bragança

**Mário J. Costa**
Polytechnic Institute of Guarda

The aim was to examine the variation of linear and nonlinear proprieties of the behavior in participants with different levels of swimming expertise among the four swim strokes. Seventy-five swimmers were split into three groups (highly qualified experts, experts and nonexperts) and performed a maximal 25m trial for each of the four competitive swim strokes. A speed-meter cable was attached to the swimmer's hip to measure hip speed; from which speed fluctuation (dv), approximate entropy (ApEn) and fractal dimension (D) variables were derived. Although simple main effects of expertise and swim stroke were obtained for dv and D, no significant interaction of expertise and stroke were found except in ApEn. The ApEn and D were prone to decrease with increasing expertise. As a conclusion, swimming does exhibit nonlinear properties but its magnitude differs according to the swim stroke and level of expertise of the performer.

***Keywords:*** swimming, nonlinear parameters, variability, predictability, complexity

To displace in water, a swimmer concurrently performs several limbs' motions that must be properly synchronized. These actions aim to increase the thrust (propulsive forces) and minimize the resistance (drag force) (Barbosa, Bragada, Reis, Marinho, Carvalho & Silva, 2010a). Swim speed is the result of the interaction between these two external forces acting upon the subject within each stroke cycle and over different stroke cycles (Craig, Termin & Pendergast, 2006). Therefore the assessment of the intracyclic and intercyclic variations of the swim speed is a

Barbosa and Goh are with the Nanyang Technological University, Singapore. Morais is with the Polytechnic Institute of Bragança, Bragança, Portugal. Costa is with the Polytechnic Institute of Guarda, Guarda, Portugal. Address author correspondence to Tiago M. Barbosa at tiago.barbosa@nie.edu.sg.